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Avian granivores consume flowers, not just seed, of the Top End Bamboo *Bambusa arnhemica*

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"Who eats bamboo seed? Everybody does." So wrote Janzen (1976) in his classic work on the gregarious flowering and subsequent die-off of many bamboos. Janzen collated a large anecdotal record demonstrating aggregation (often in huge numbers) at flowering stands of bamboo, and consumption of bamboo seed, by humans, many species of rodent, pigs, elephants, rhinoceros, a range of bovids and cervids, monkeys, a variety of birds, and insects. During a drought in India, an estimated 35 000 people survived on bamboo seed (Lowrie 1900 cited in Janzen 1976). Mass-flowering events are often followed by rodent plagues (Chauhan & Saxena 1985, Jaksic & Lima 2003). At least one bird species, the Pied Mannikin *Lonchura fringilloides* of East Africa, appears to be a bamboo seed specialist (Jackson 1972).

The seeds of most bamboos are large, nutritious grains (caryopses) that lack defensive toxins (Pathak 1979, Bhargava *et al.* 1996). Janzen (1976) proposed that the peculiarly infrequent gregarious-flowering behaviour and subsequent death of certain bamboos was an evolutionary response to the vulnerability of its seeds to consumers, in which huge production of seed alternates with many years of no production at all, the latter ensuring that populations of seed consumers cannot build up to match the abundance of the resource - the *seed predator satiation hypothesis*. Effective seed predator satiation during a mast-fruiting event, and subsequent total failure of seed under unsatiated conditions, has been documented in Bornean dipterocarps (Curran & Webb 2000). However, the improved pollination rates achievable by wind-pollinated species when neighbours are flowering, along with several other possibilities, are potential additional or alternative explanations for the adaptive value of infrequent but massive fruiting events (Kelly 1994, Sakai 2002).

Bambusa arnhemica, a bamboo endemic to the north-western Top End of the Northern Territory, flowers gregariously at intervals of *c.* 40–50 years and seeds prolifically (Franklin 2004). Simple or compound flowering branches up to 2.5 m long bear clusters (inflorescences) of pseudospikelets at each node. In this note, I report observations, obtained in the course of studies of *B. arnhemica* flowering behaviour, of birds consuming plant material from the inflorescences of *B. arnhemica*. When I located birds amongst standing *B. arnhemica* inflorescences, I examined them through binoculars. If any individual was observed consuming any part of the inflorescence (*cf* probing in apparent search of insects), I noted the species, and counted or estimated the flock size. To maximise independence of records, a bird species was

recorded in this way at a maximum of one location per day. I also report aviary trials to test my suspicions about what the birds were consuming.

I obtained 93 observations of 11 bird species foraging on the inflorescences of *B. arnhemica*, comprising four cockatoo, three parrot and four finch species (Table 1). Reflecting where I spent most time in flowering bamboo stands, 83 records (89%) were in the Adelaide River catchment, the remainder being shared between the Daly, Finniss and Mary River catchments. Reflecting the main flowering and seeding times of *B. arnhemica* (Franklin, unpubl.), 89 (96%) of records were within the period July to December, with a peak in October (28 records, 30%). The most frequently recorded and numerous species were Rainbow Lorikeet and Chestnut-breasted Mannikin, followed by Double-barred Finch and Red-tailed Black-Cockatoo. Rainbow Lorikeets fed particularly persistently, moving slowly from inflorescence to inflorescence in a manner that could feasibly have serious adverse affects on the productivity of clumps, especially if only isolated clumps were flowering. Mannikins, on the other hand, tended to move through an area, feeding fairly briefly on each clump. Cockatoos may be relatively under-reported because they were often wary and flushed before I could confirm their behaviour. Several small honeyeater species, notably the White-throated Honeyeater *Melithreptus albogularis* and the Brown Honeyeater *Lichmera indistincta*, were frequently recorded probing inflorescences, but I saw no evidence that they were consuming plant material. Granivorous birds were also observed foraging on the ground below flowering or recently-seeded bamboo clumps, but the identity of the food being consumed could not be confirmed.

Table 1. Birds observed feeding at inflorescences of wild bamboo *Bambusa arnhemica*.

Species	No. of records	Median flock size (range)
Cacatuidae		
Red-tailed Black-Cockatoo *Calyptorhynchus banksii*	9	10 (2-100)
Galah *Cacatua roseicapilla*	1	4 (4)
Little Corella *Cacatua sanguinea*	4	8.5 (7-13)
Sulphur-crested Cockatoo *Cacatua galerita*	4	1 (1-2)
Psittacidae		
Rainbow Lorikeet *Trichoglossus haematodus*	21	5 (2-60)
Red-winged Parrot *Aprosmictus erythropterus*	7	2 (1-4)
Northern Rosella *Platycercus venustus*	5	2 (1-5)
Passeridae		
Double-barred Finch *Taeniopygia bichenovii*	14	3 (1-10)
Long-tailed Finch *Poephila acuticauda*	1	8 (8)
Crimson Finch *Neochmia phaeton*	7	2 (1-5)
Chestnut-breasted Mannikin *Lonchura castaneothorax*	20	10 (1-30)

I started with the assumption that the listed bird species were seeking and consuming bamboo seed, but soon became suspicious that this was frequently not the case. I noticed that bird activity at the inflorescences appeared related to flowering *per se* and not to my unquantified observations about seed availability, the latter being sparse except in October or November. On a number of occasions when I saw much active foraging amongst the inflorescences, I made an effort to locate seed on them, but found few. Furthermore, the rapid and repetitive bill movements of foraging granivores that I observed repeatedly was hardly consistent with either direct consumption or fragmentation of seeds. So far as I could determine, finches and Rainbow Lorikeets appeared to be chewing 'empty' green florets, but I could not determine what the cockatoos were consuming.

My suspicions that flowers were being consumed were further raised when I measured *B. arnhemica* seeds. These are grains with a mean air-dry weight of 19.3 mg and mean dimensions of 7.6 by 2.1 mm (Franklin 2003). They weigh 3.2 times as much as seeds of Annual Spear-grass *Sarga intrans* and 1.5 times those of Giant Spear-grass *Heteropogon triticeus* (Dostine & Franklin 2002). In a study of finch diets (Gouldian *Erythrura gouldiae*; Masked *Poephila personata*; and Long-tailed *P. acuticauda*; Dostine & Franklin 2002), seeds of *S. intrans* were the largest seed consumed whole, those of *H. triticeus* being consumed only after being fragmented. As Crimson Finch and especially Double-barred Finches are smaller-bodied and have smaller bills than any of these species (Franklin, unpubl.), and bill size in Australian grass-finches is directly related to the size of seed consumed (Todd *et al.* 2003), it seemed most unlikely that these birds could swallow whole *B. arnhemica* seeds.

To test the interest of birds in inflorescences lacking seed, and to identify what else they might be consuming, I collected sections of *B. arnhemica* flowering branches, each around 15-20 cm long and containing two or three inflorescences, from the Adelaide River. I checked each section thoroughly and removed the few ripe or un-ripe seeds, which were readily detected by the swollen firmness of the floret. On the same afternoon, I took them to the Territory Wildlife Park, where two to three sections were placed in each of four small aviaries, either attached to the wire or on the ground (as advised by keeping staff based on what the birds were used to). Aviaries were selected to represent a range of the finches and parrots available including, where possible, the species listed in Table 1. The birds' response was observed from a distance of from 3–5 metres for about 10 minutes.

Rainbow Lorikeets and Hooded Parrots showed no sign of interest in the branch sections, and after several 'exploratory' pecks they were ignored by Pictorella Mannikins (Table 2). However, Yellow-rumped Mannikins, Gouldian Finches and one Red-winged Parrot fed persistently and systematically on the inflorescences. The Red-winged Parrot worked over each inflorescence, breaking off most or all of an entire pseudospikelet before running it sideways through its bill and masticating it thoroughly, then dropping the remaining green material (the lemma and palea).

Yellow-rumped Mannikins worked along the spikelets, often removing one or more florets and masticating them, shedding the green matter afterwards. Gouldian Finches pecked persistently at the inflorescences, working along the spikelets, but did not obviously remove anything. In the case of Yellow-rumped Mannikins and the Red-winged Parrot, it was clear that the internal contents of the florets, and not the outer glumes, were sought and consumed, and that these were obtained by squeezing out the contents. It is not clear what the Gouldian Finches were doing or obtaining, but they could have been obtaining droplets or fragments left by the mannikins. The observed foraging behaviour by Yellow-rumped Mannikins and the Red-winged Parrot was consistent with what I had observed in the wild.

Table 2. Response of aviary birds to provision of seedless *Bambusa arnhemica* inflorescences, 22 August 2001.

Aviary	Species	Response to inflorescences
1	2 Red-winged Parrots *Aprosmictus erythropterus* 2 Rainbow Lorikeets *Trichoglossus haematodus*	one Red-winged Parrot systematically consumed them
2	*c.* 15 Pictorella Mannikins *Heteromunia pectoralis*	initial interest only; no consumption
3	*c.* 15 Gouldian Finches *Erythrura gouldiae* 5 Yellow-rumped Mannikins *Lonchura flaviprymna*	persistent consumption by both species, repeated when a second batch of inflorescences were provided
4	4 Hooded Parrots *Psephotus dissimilis*	no sign of interest

The contents of *B. arnhemica* florets, comprising the ovary, lodicules, stigmas and stamens, are evidently of considerable interest as a food source to a range of birds. Whilst such foraging behaviour is not surprising in the dietarily versatile Rainbow Lorikeet and other parrots, and perhaps also amongst cockatoos (Higgins 1999), there is no precedent for it amongst Australian finches which are regarded as either strictly granivorous or seasonally somewhat insectivorous (Immelmann 1982, Read 1994, Dostine & Franklin 2002, Todd *et al.* 2003). Todd *et al.* (2003) did, however, report that Crimson Finches consumed lerp, a soft carbohydrate exudate produced by psyllids. There appear to be no published studies of the diet of the main finch species involved here, the Chestnut-breasted Mannikin and Double-barred Finch, but it may be of relevance that these two species and especially the mannikin are somewhat noteworthy for the frequency with which they forage from standing grass stems rather than on the ground (Immelmann 1982), a habit which might predispose them to arboreal foraging on bamboo.

Janzen (1976) cited records of Burmese jungle fowl and African monkeys feeding on bamboo flowers. Insects may damage bamboo florets (John *et al.* 1995, Koshy & Harikumar 2001). This suggests yet another dimension to the vulnerability of long-lived bamboos during the brief phase of sexual reproduction that precedes death. The value of highly synchronised flowering in satiating consumers, as postulated by the *seed predator satiation hypothesis*, may also apply to 'predators of flowers'.

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Seed-eating birds avidly consume flowers of the Top End Bamboo *Bambusa arnhemica*. (Don Franklin)